



6D Merge

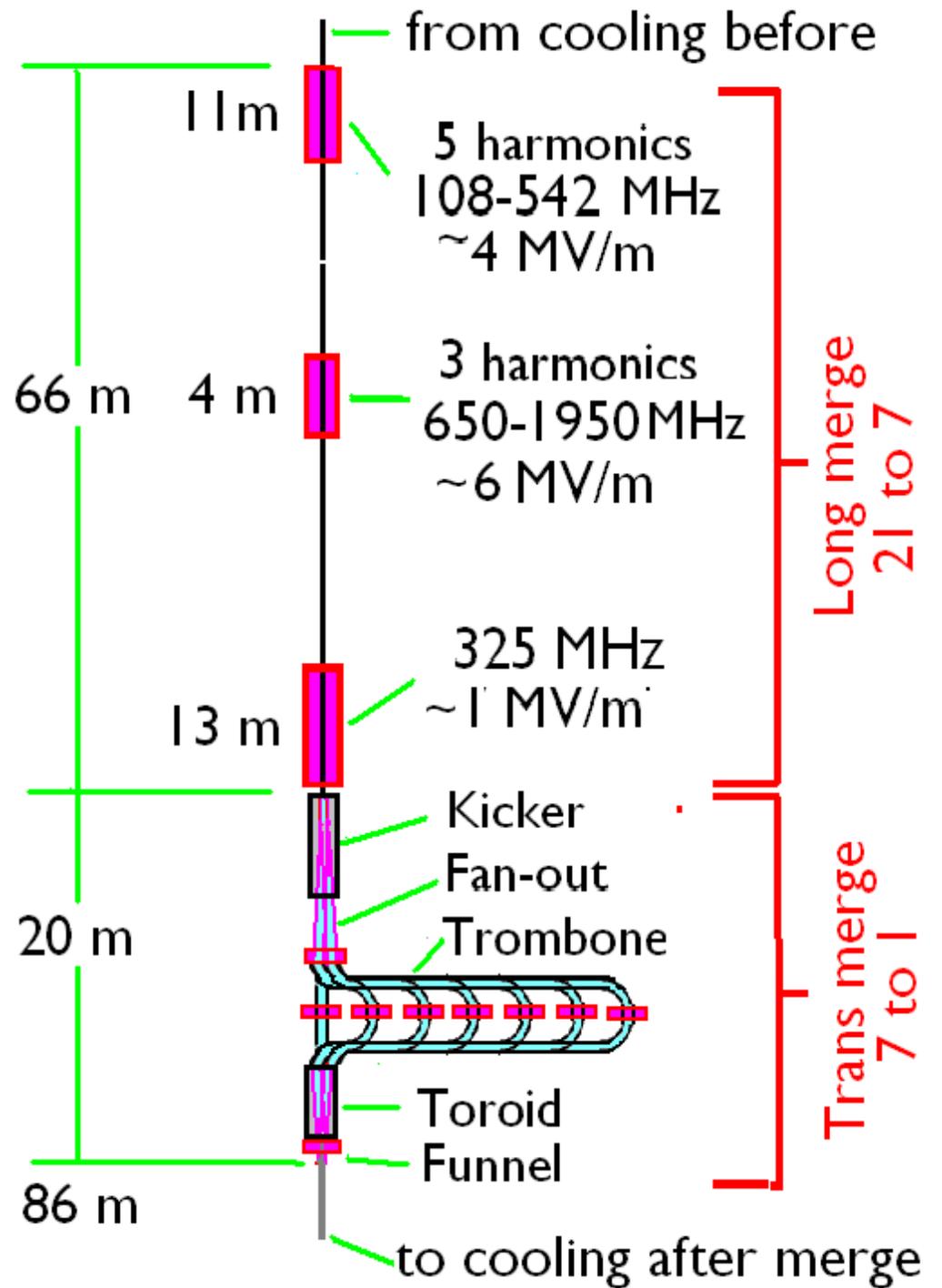
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(BNL)

9/18/2013

6D Merge

I did a new 1D design of this first part.
Bao will report G4BL simulation

I have starting on this



Progression along longitudinal merge

Only 6 of the 21 bunches shown

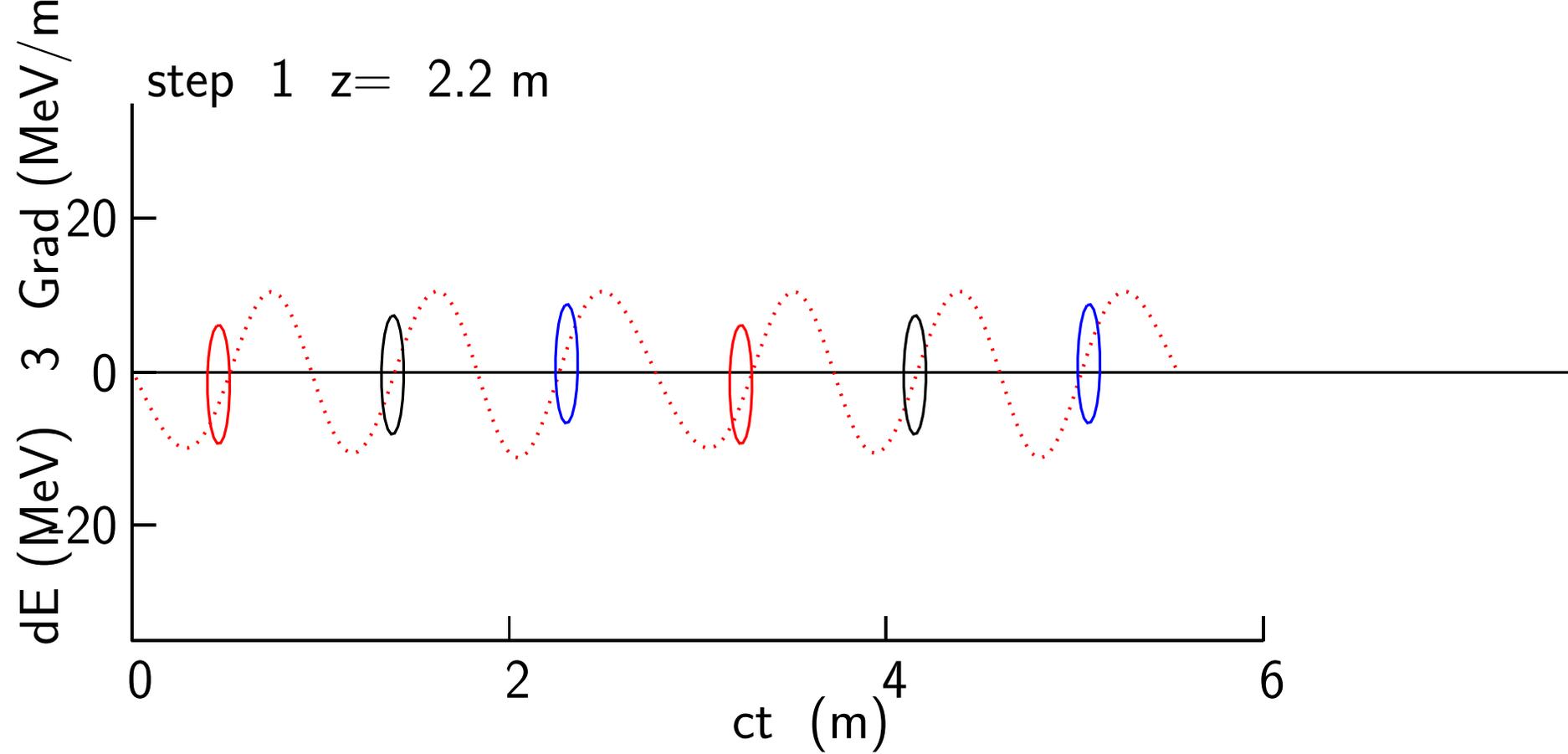


Fig. 1

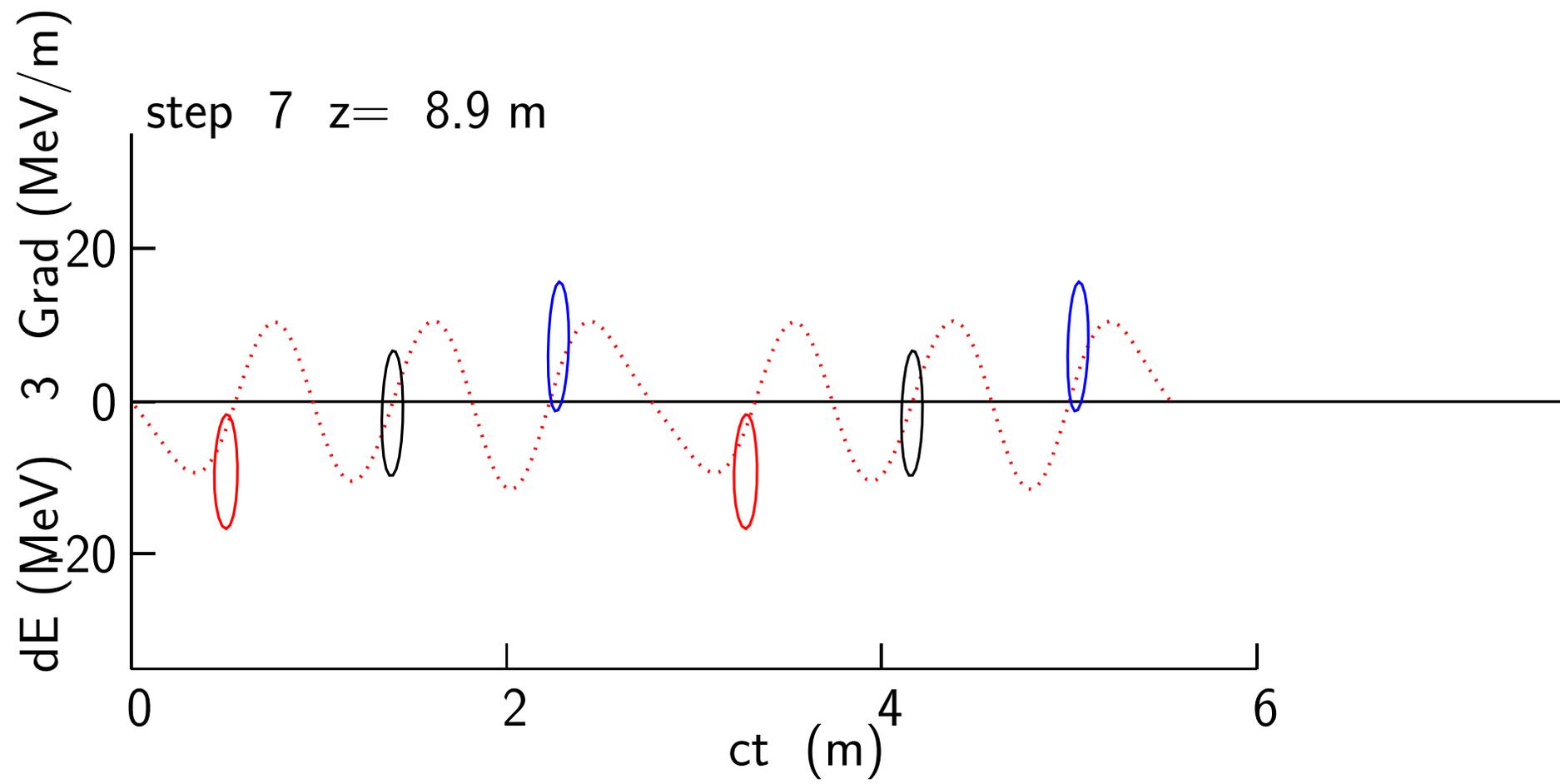


Fig. 2

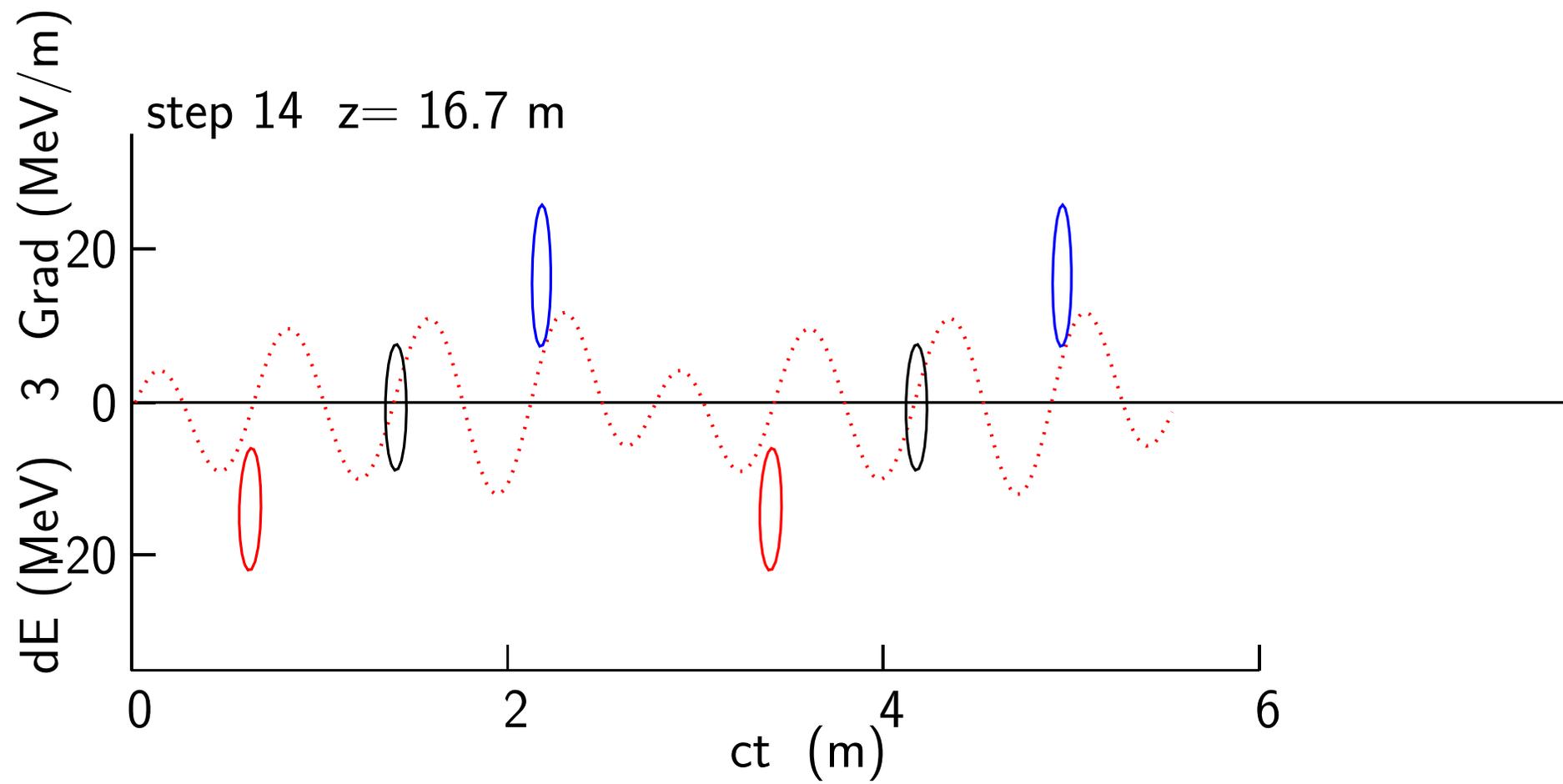


Fig. 3

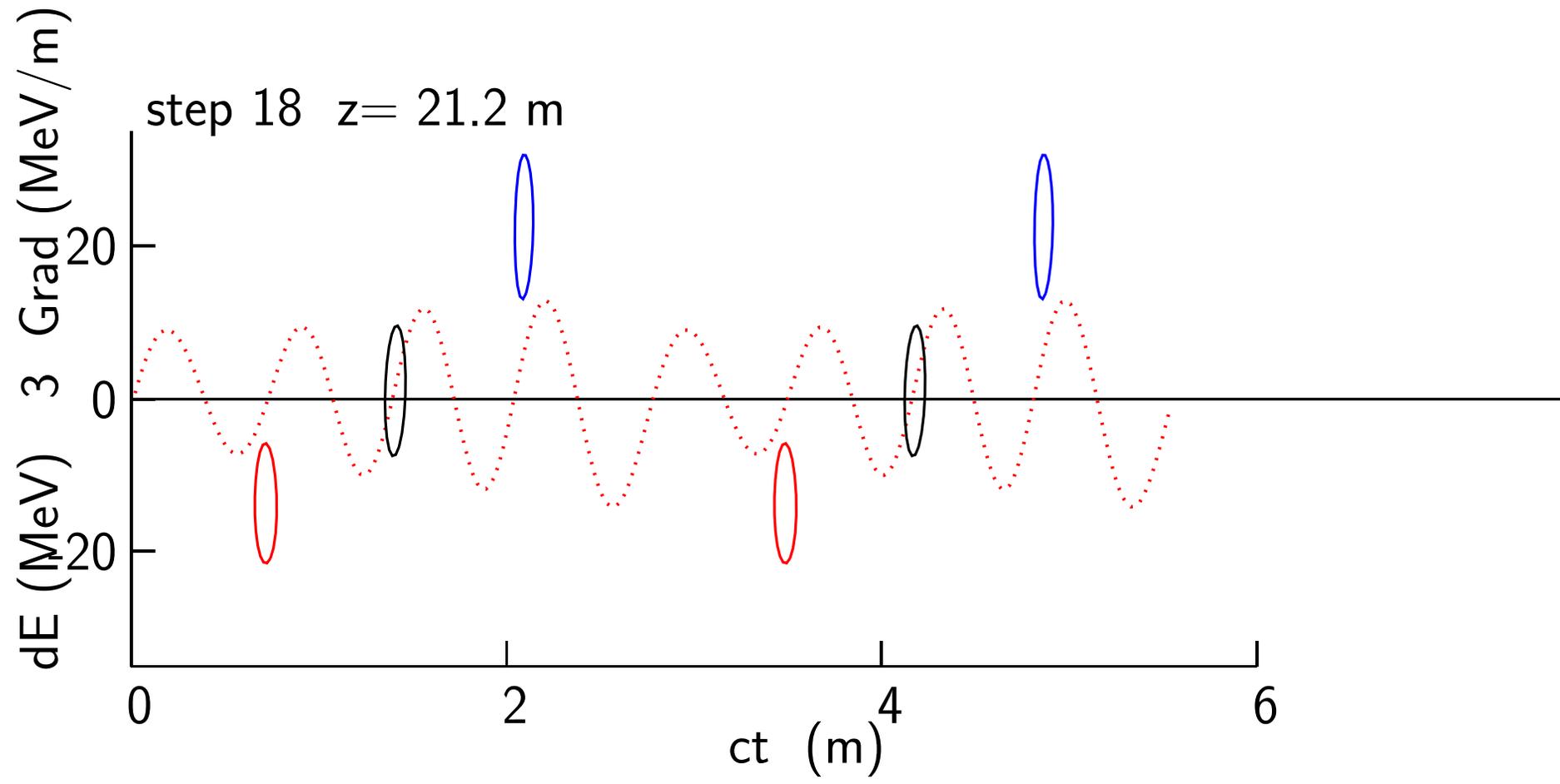


Fig. 4

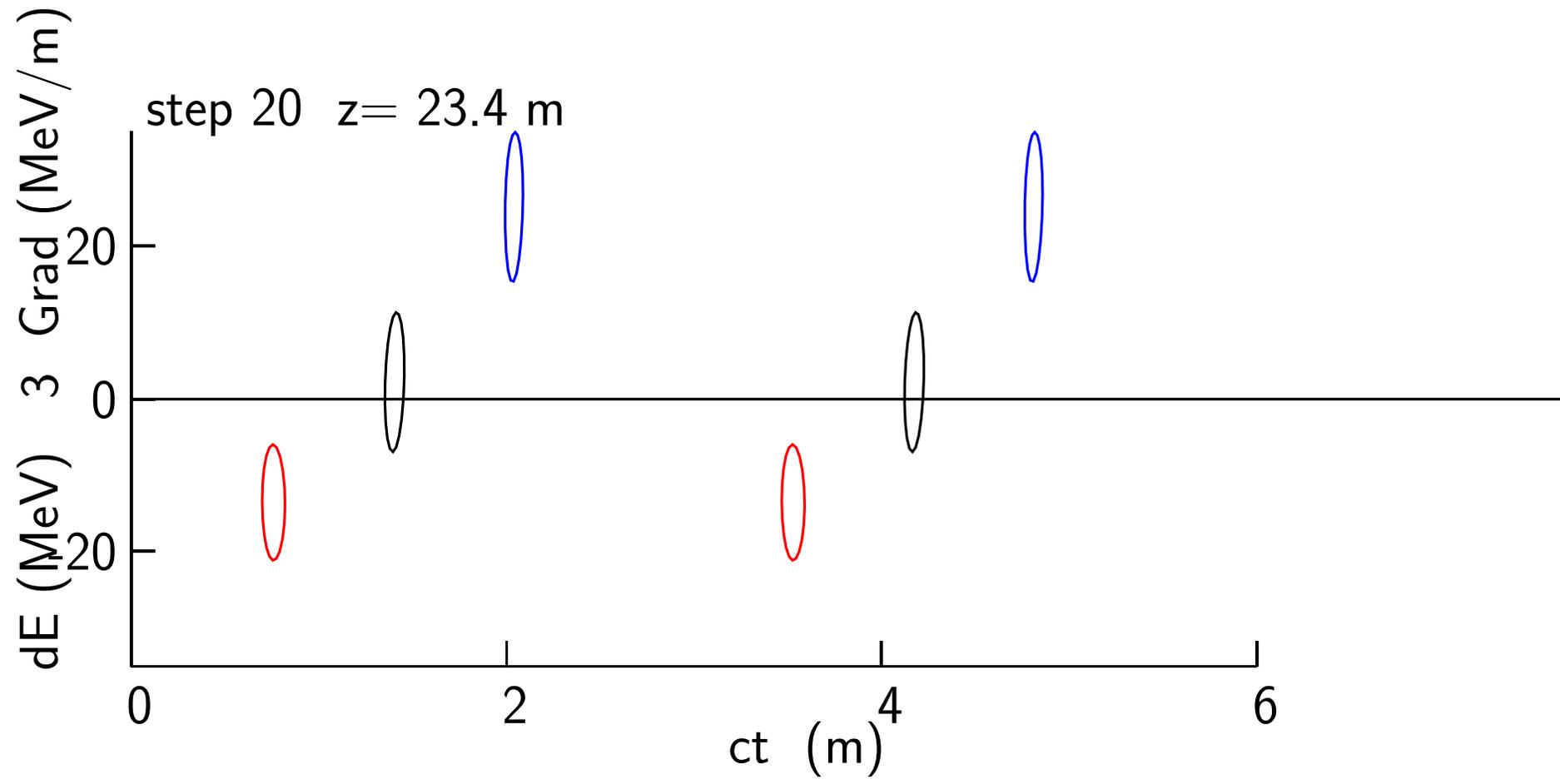


Fig. 5

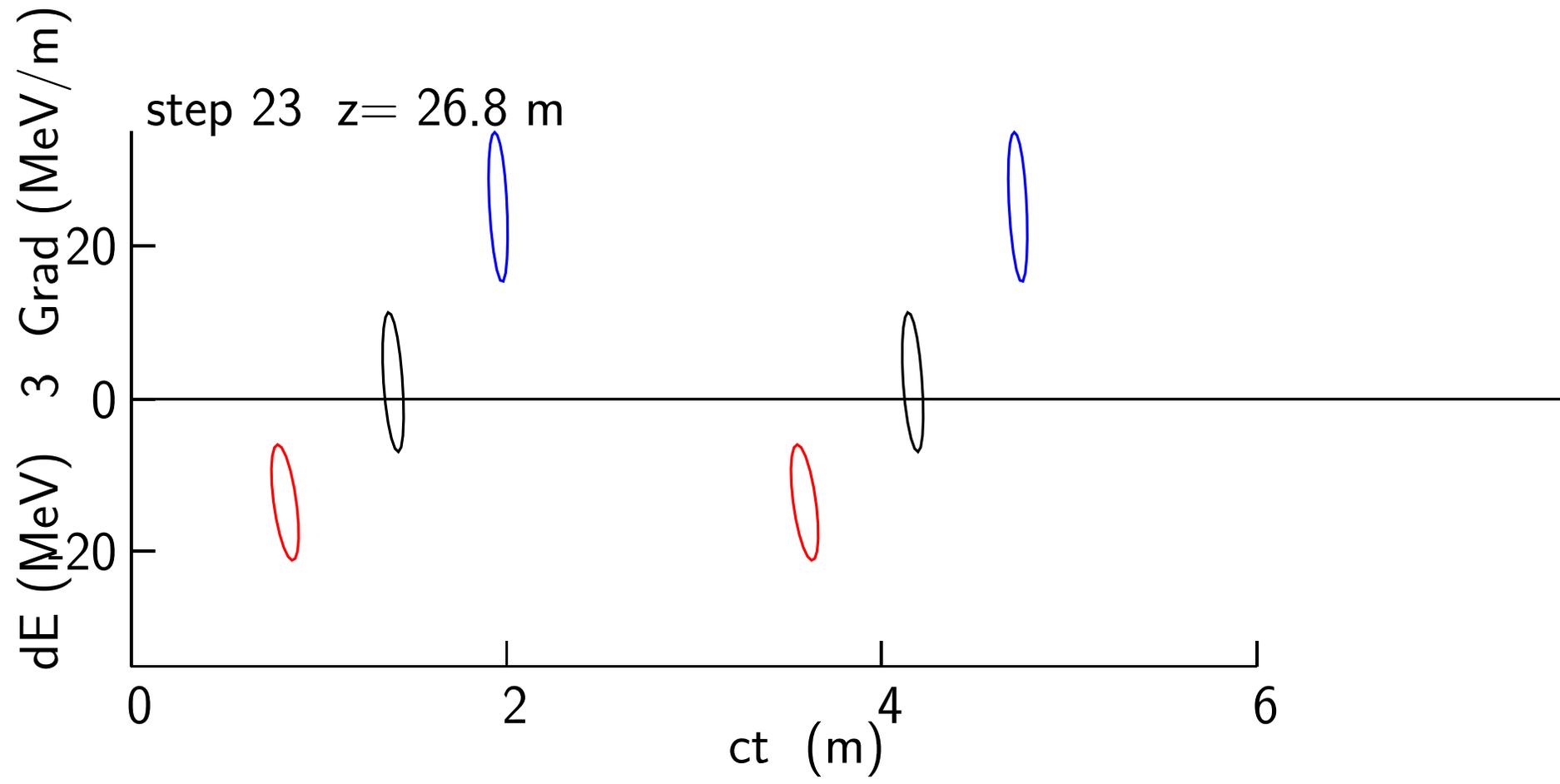


Fig. 6

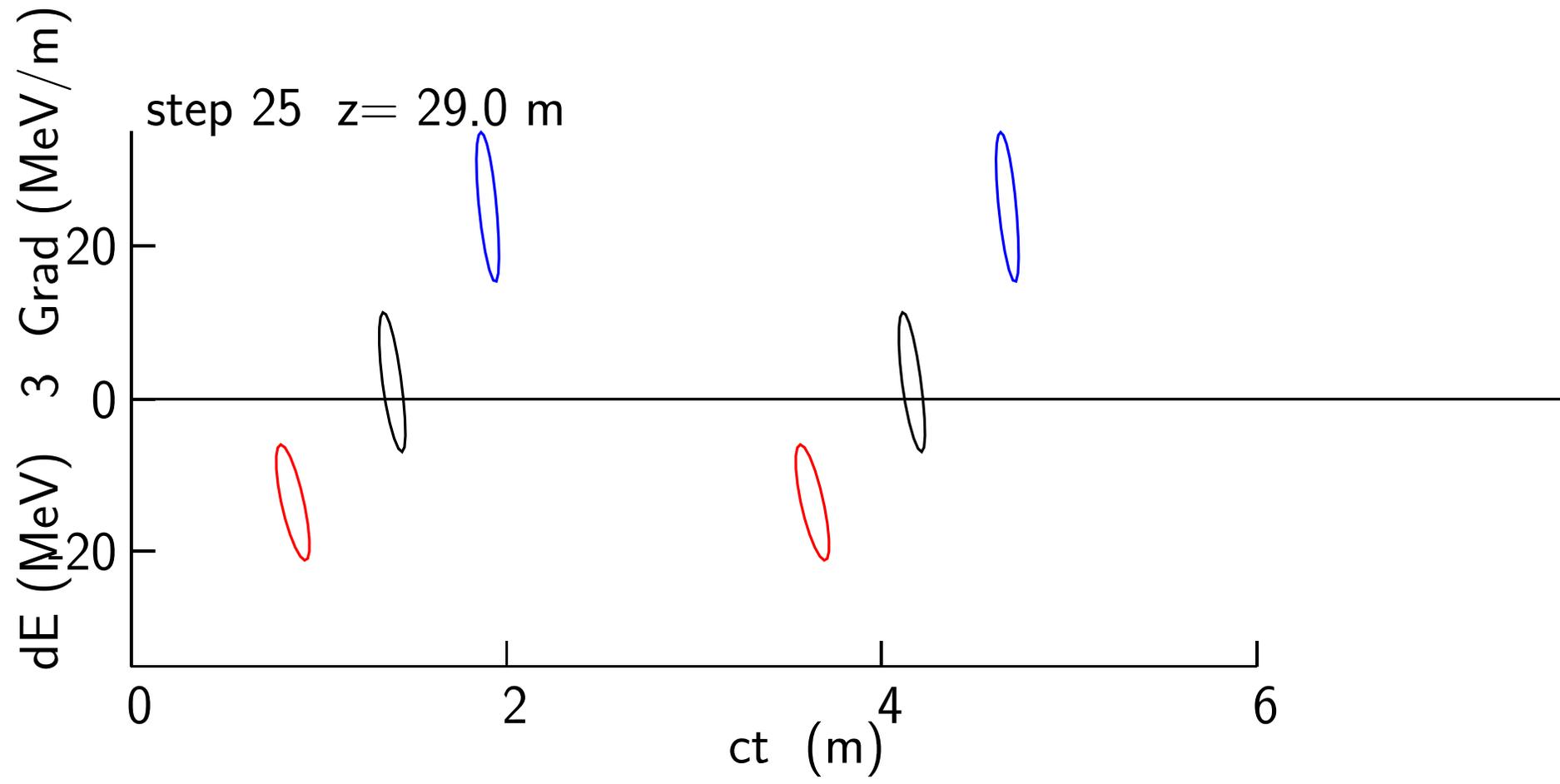


Fig. 7

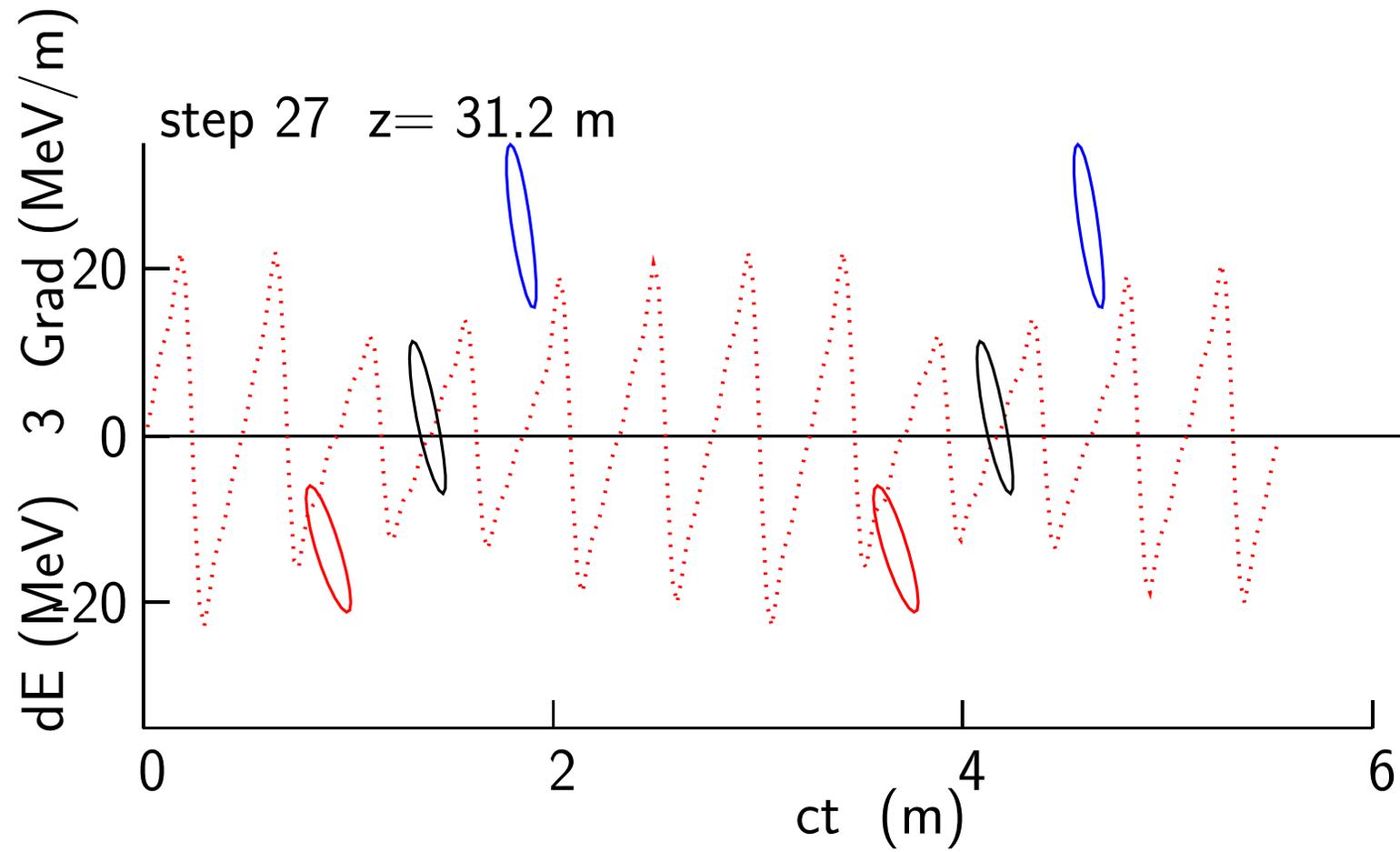


Fig. 8

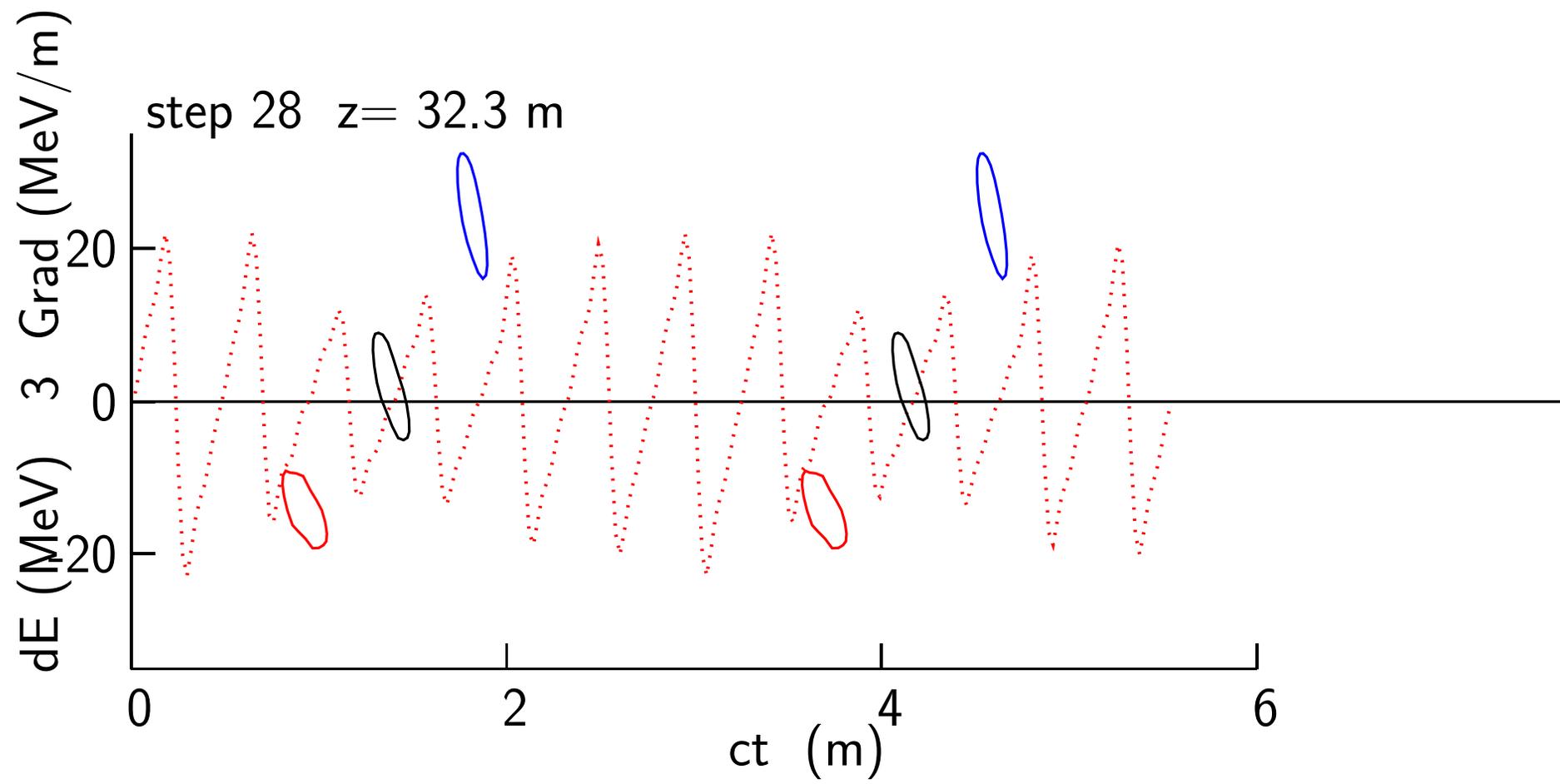


Fig. 9

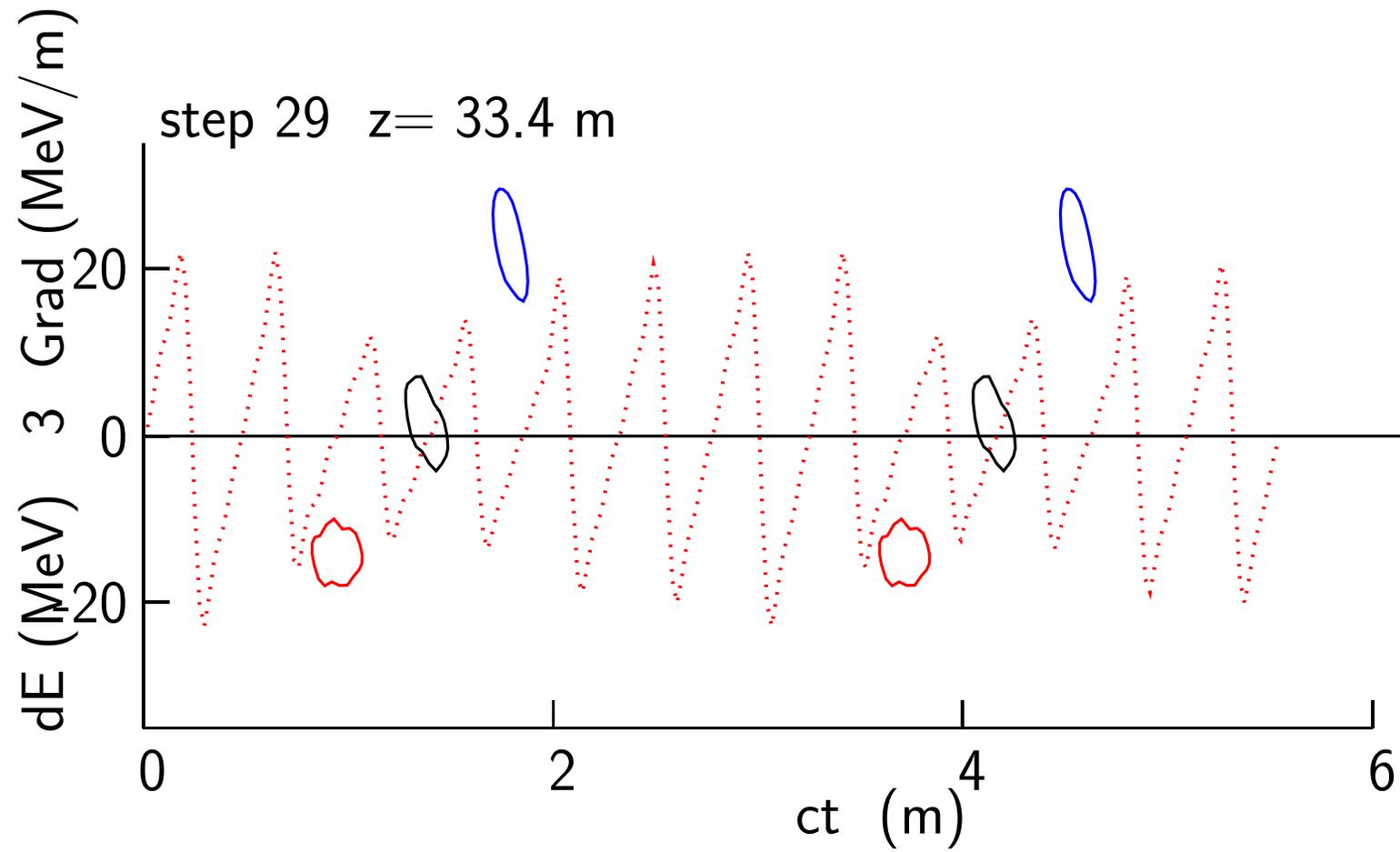


Fig. 10

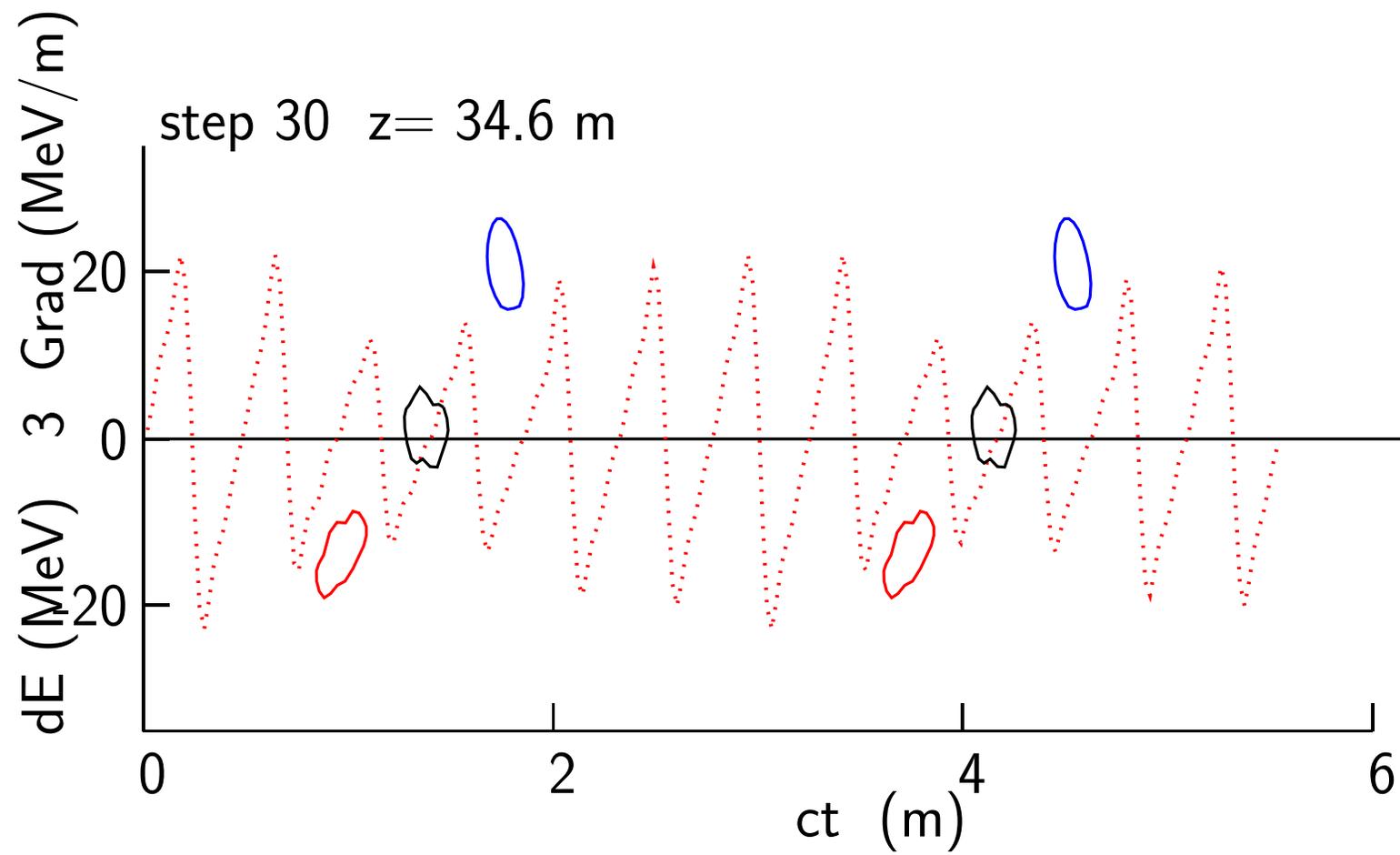


Fig. 11

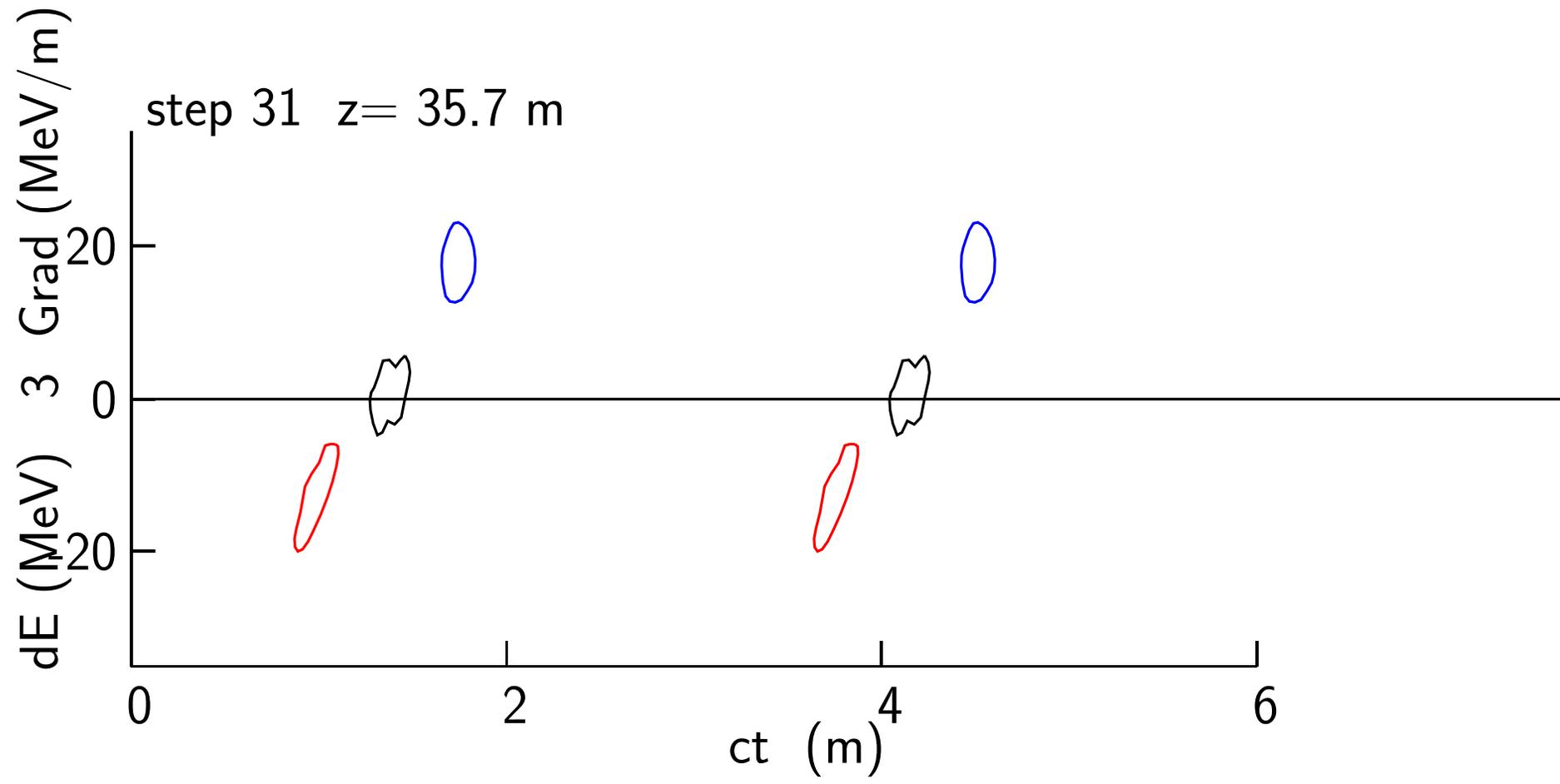


Fig. 12

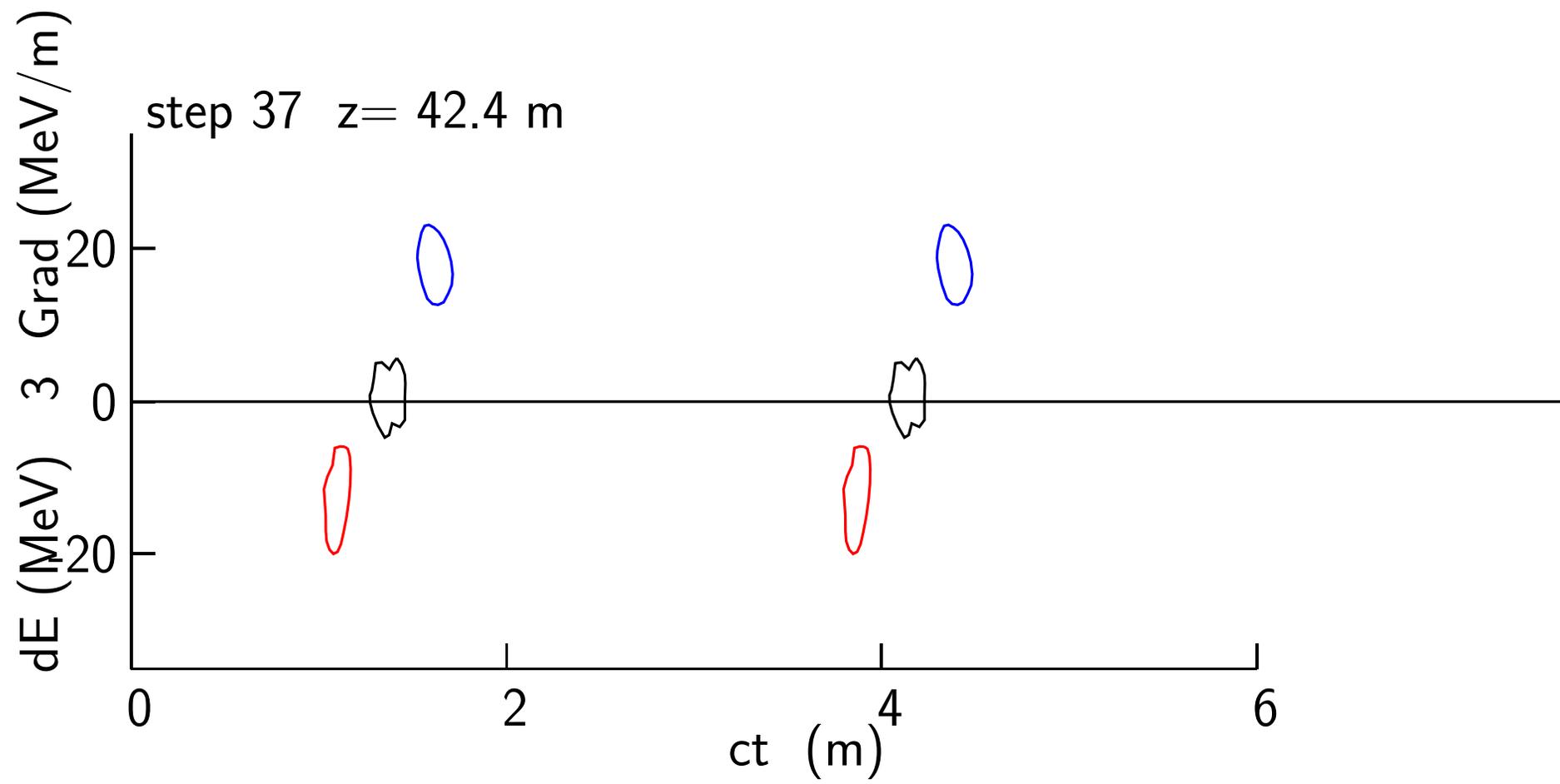


Fig. 13

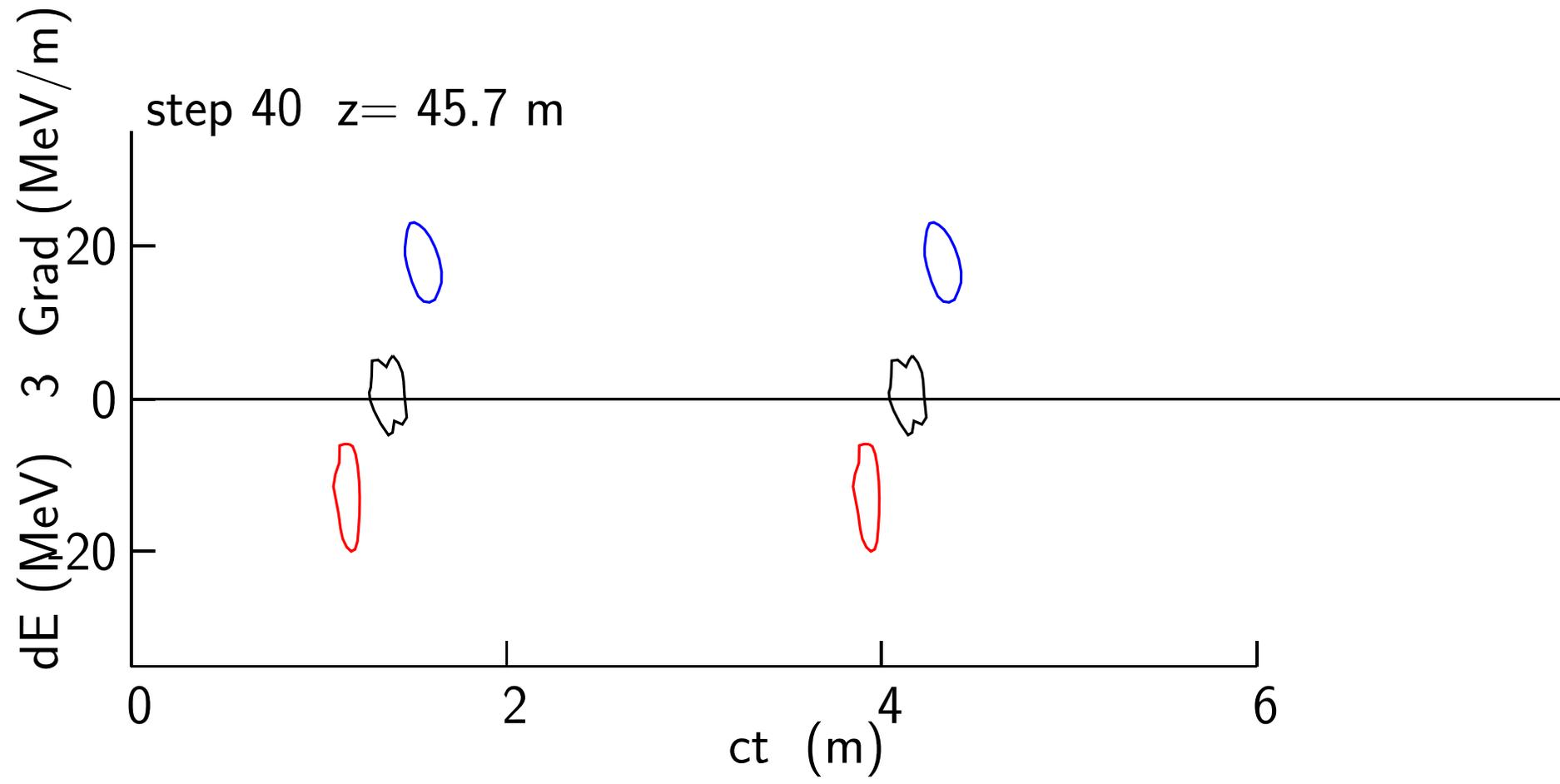


Fig. 14

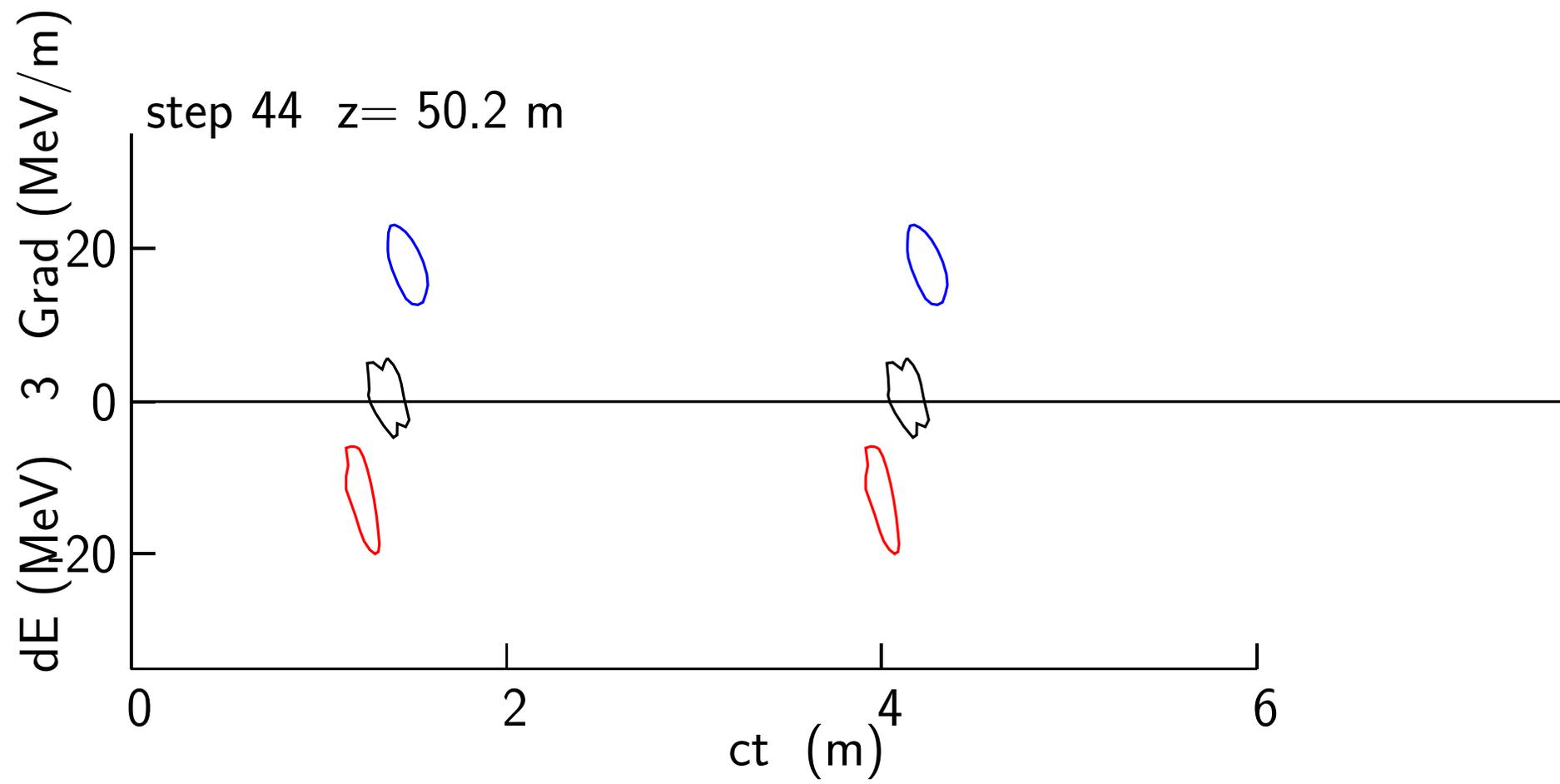


Fig. 15

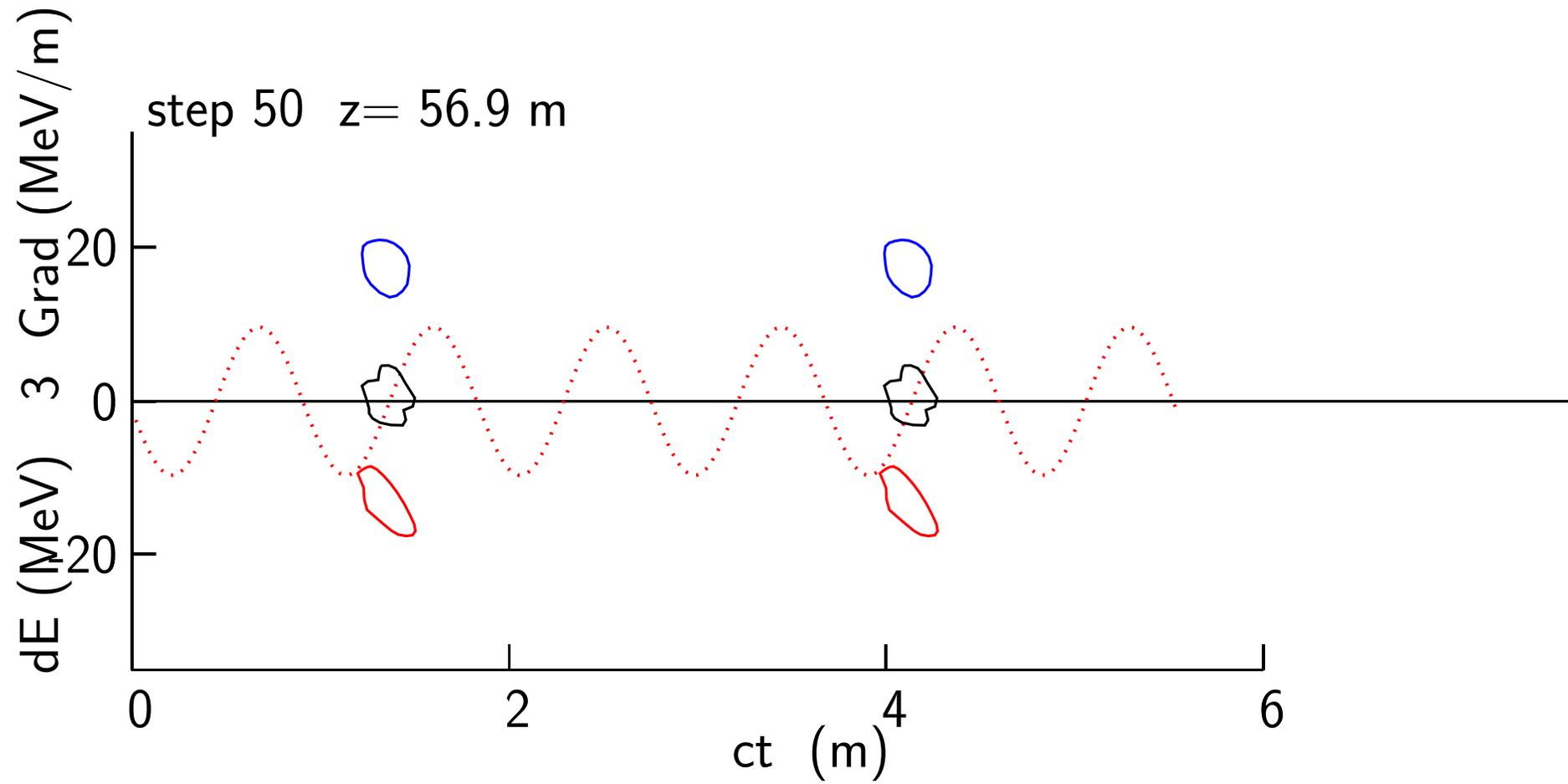


Fig. 16

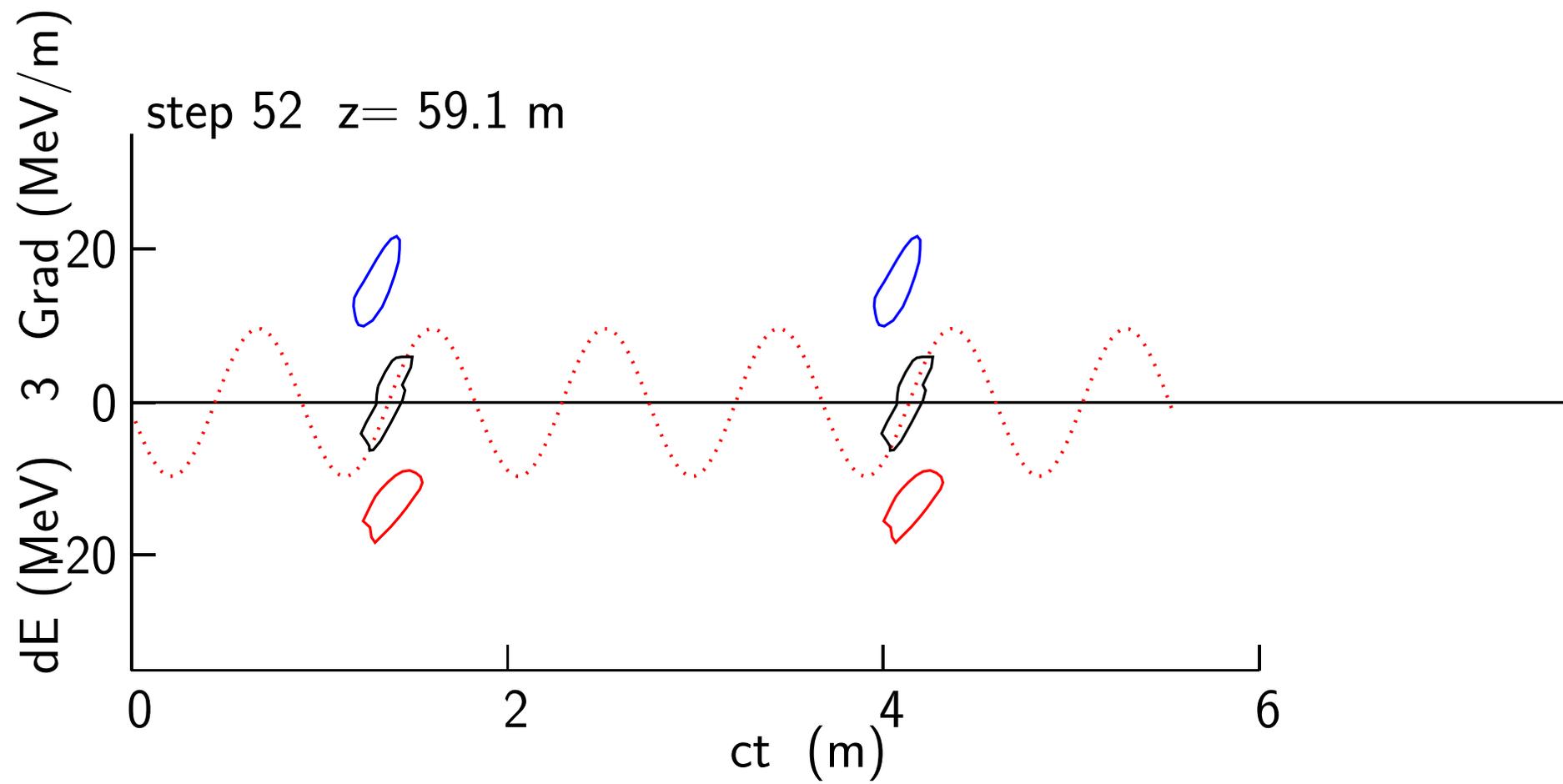


Fig. 17

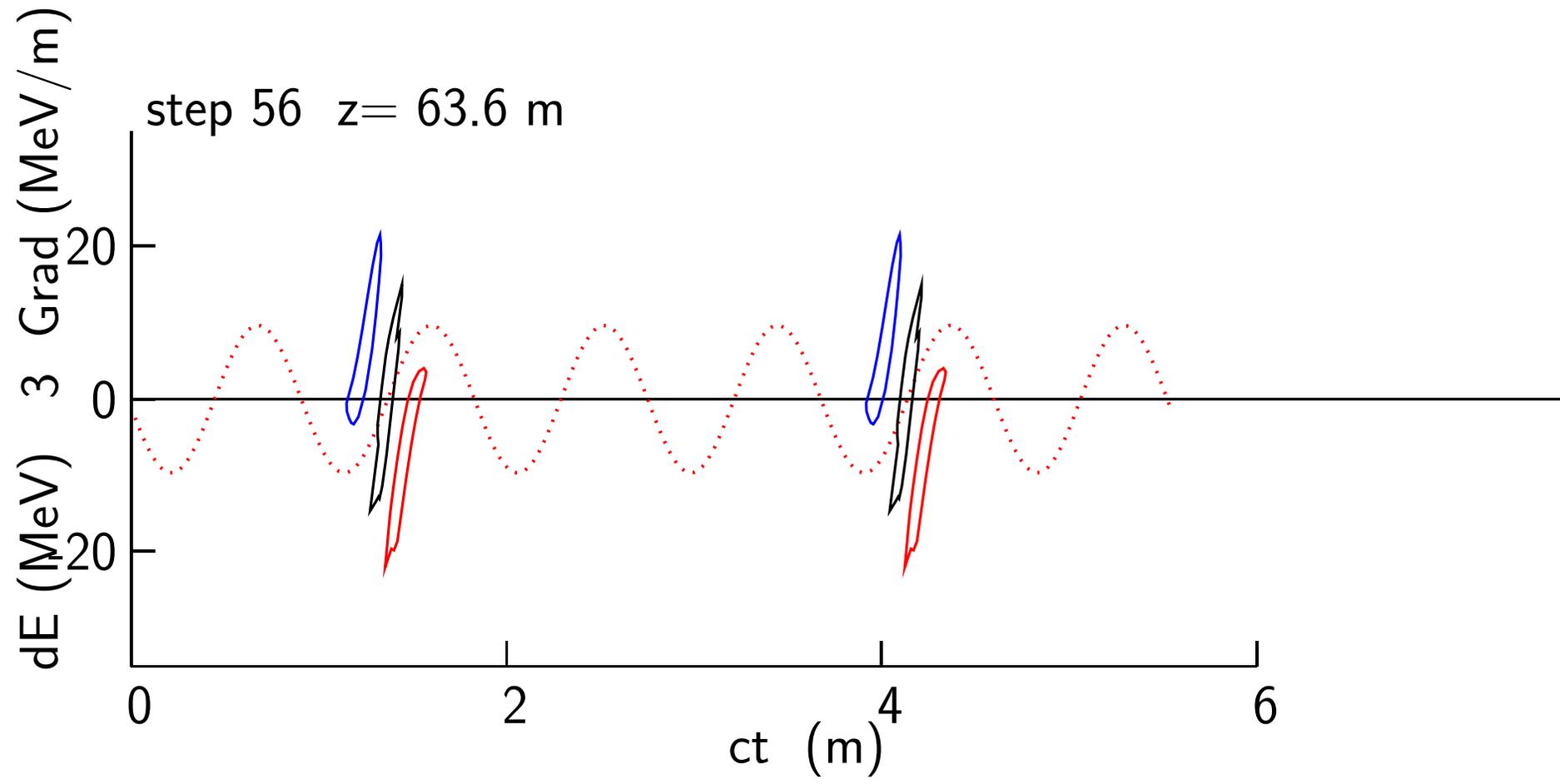


Fig. 18

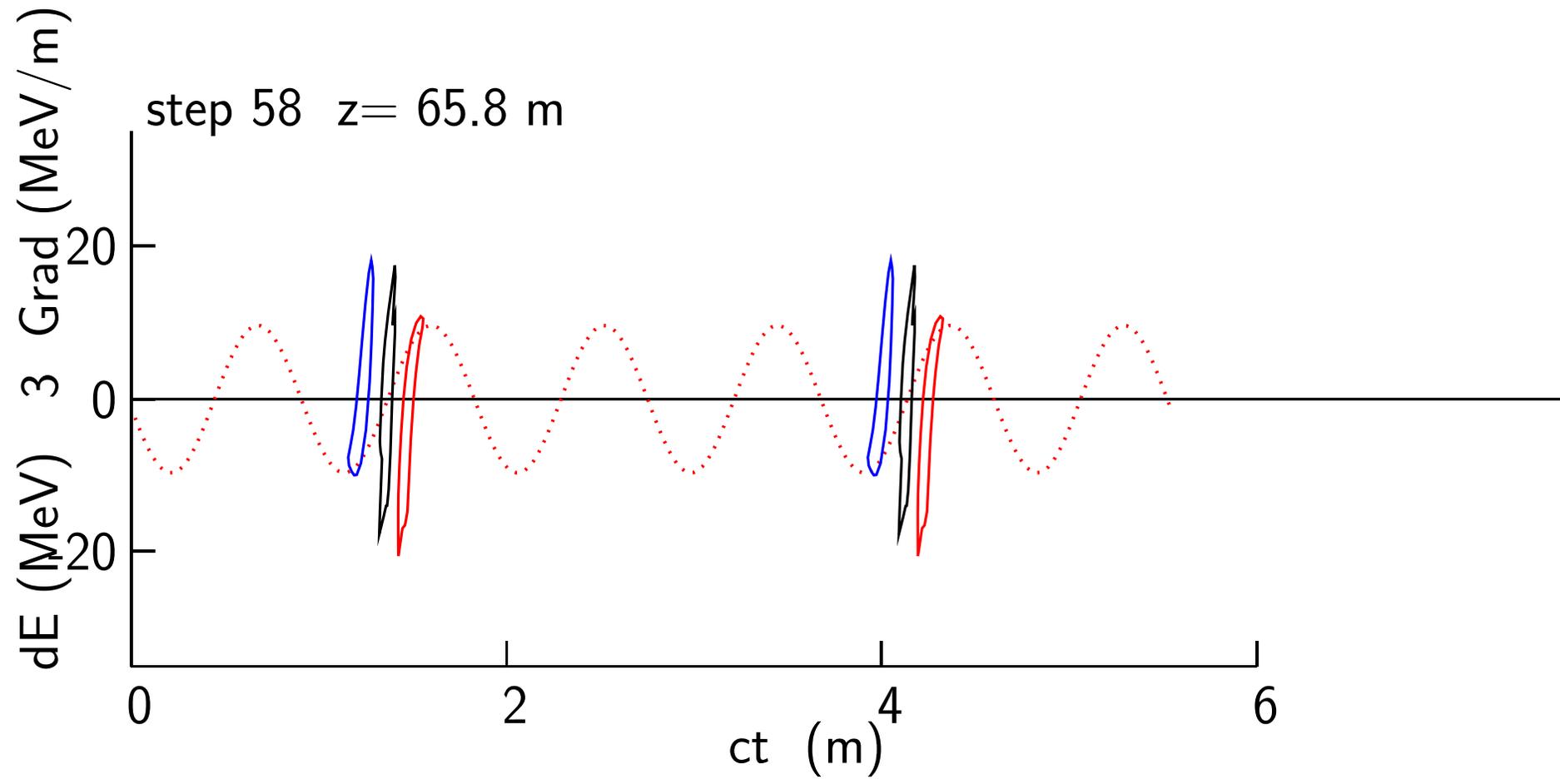


Fig. 19

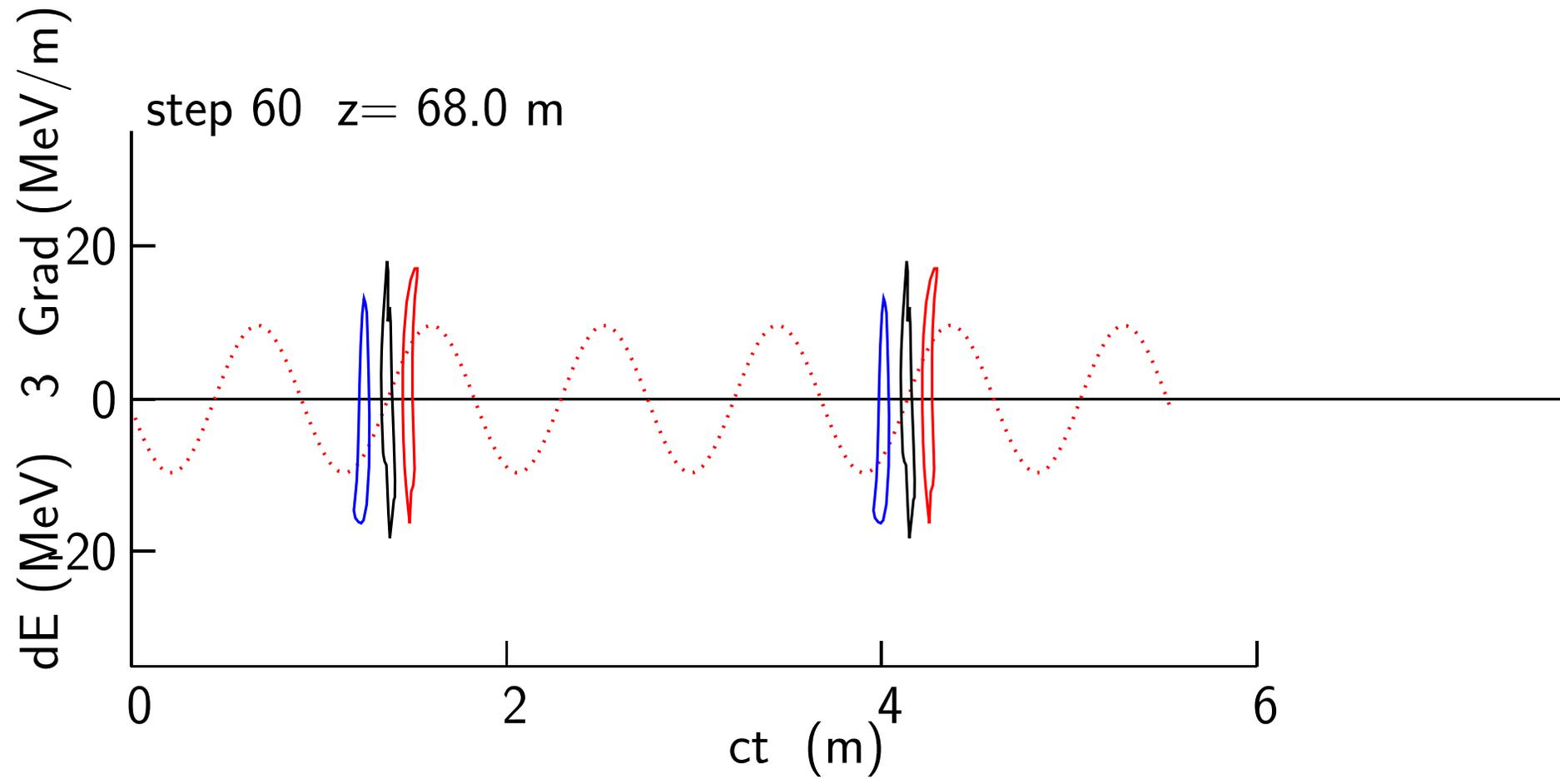
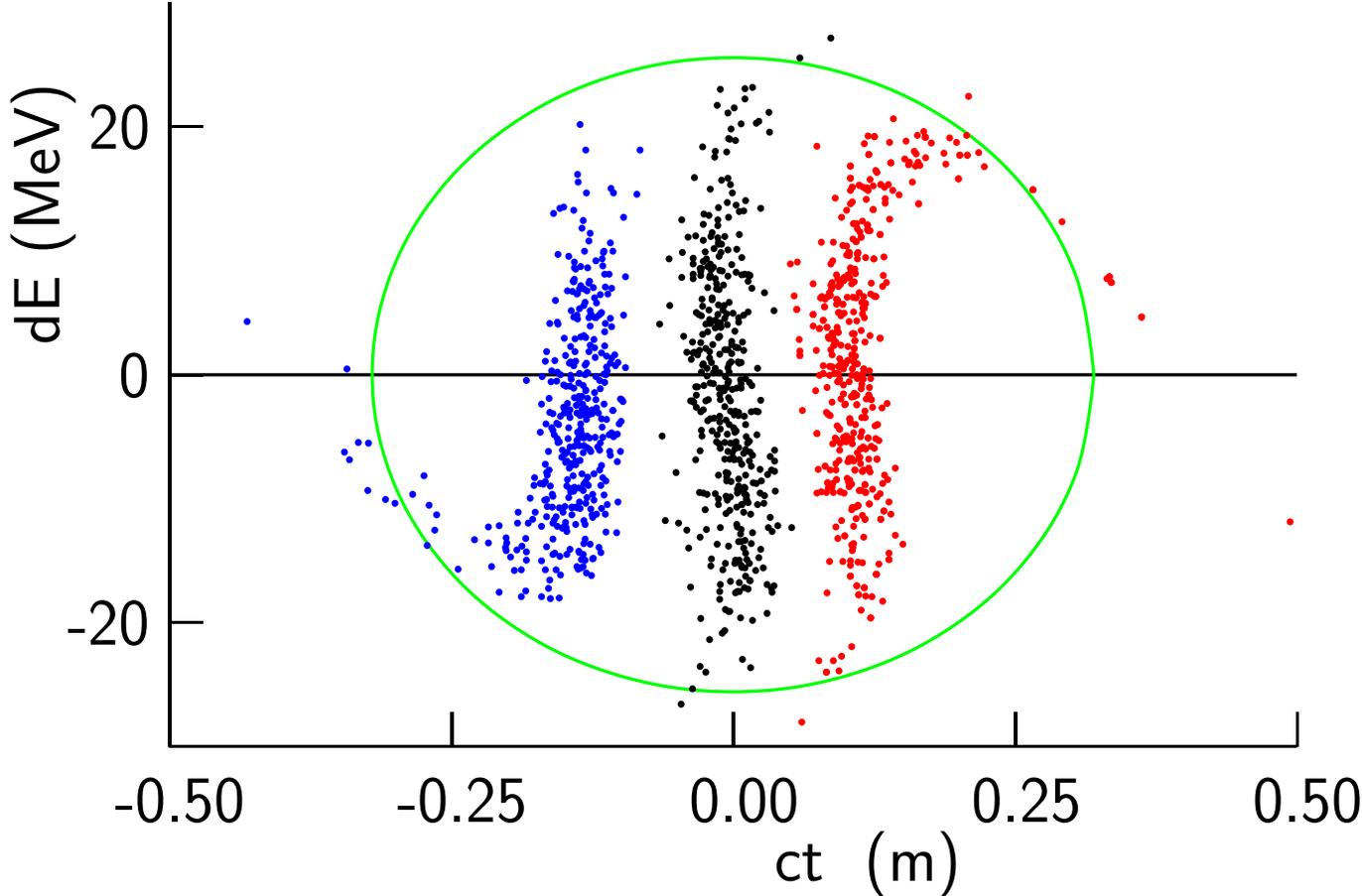


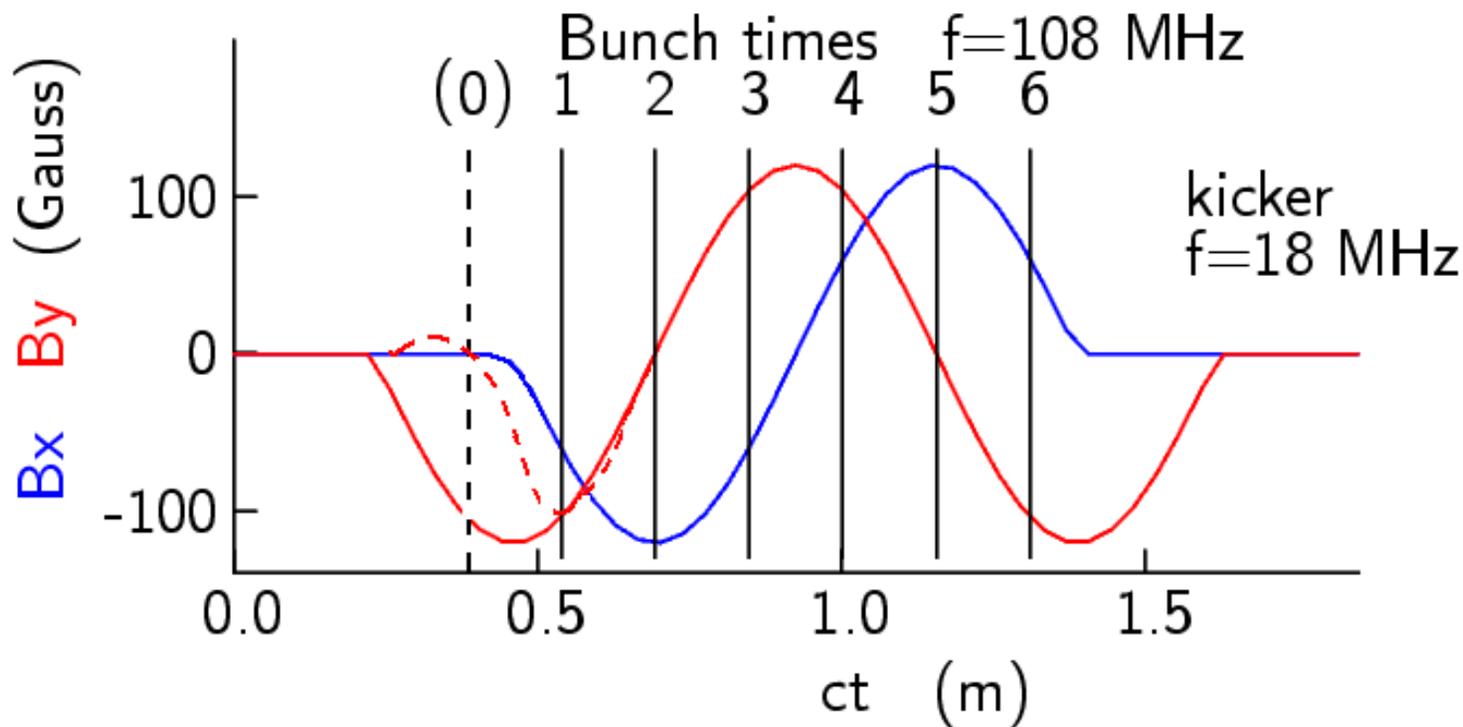
Fig. 20

Scatter at end for combined all bunches



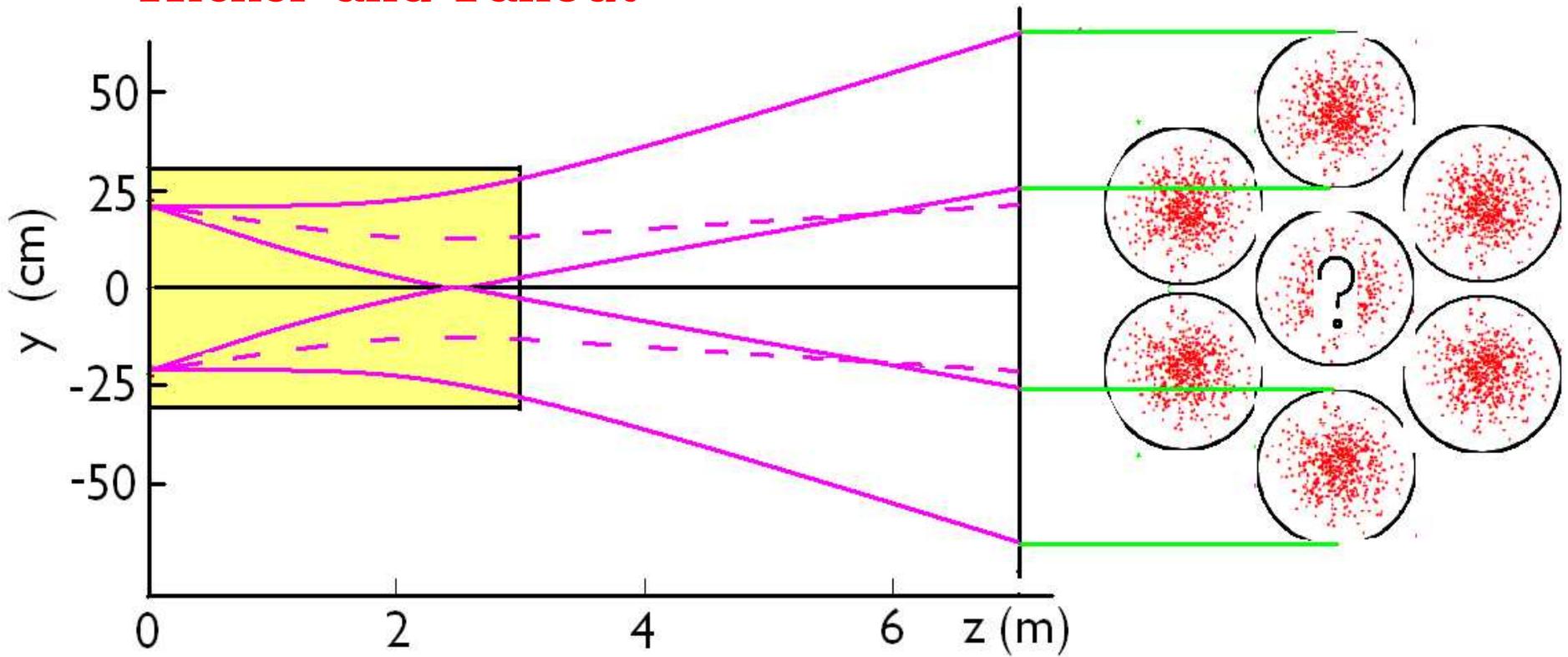
Transverse merging: 6(7) \rightarrow 1 bunch

- Use a kicker with both x and y periodic fields
- Kicking the bunches into 6(7) different channels, with differing lengths to bring all four to the same time:
a Trombone as proposed by Ankenbrandt
- Merge these bunches using a toroidal magnet.



to merge 7 bunches requires a more difficult kicker waveform

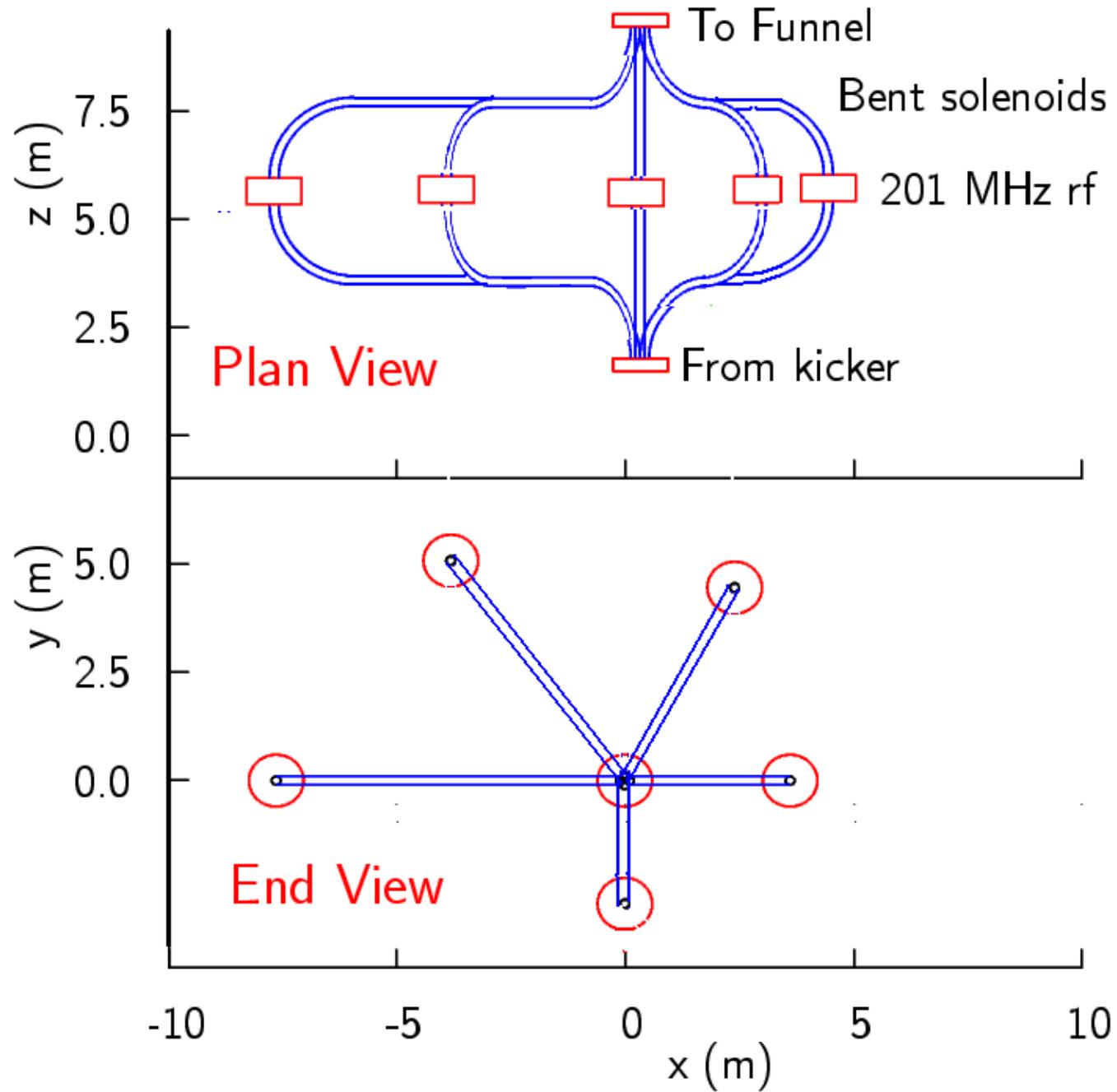
Kicker and Fanout



Kicker field	≈ 150	Gauss
Kicker length	3	m
Kicker radius	35	cm
Fanout drift	4	m

The 6(7) beams are matched into separate bent solenoid 'trombones' with differing lengths

Trombones



Old Trombone parameters and performance

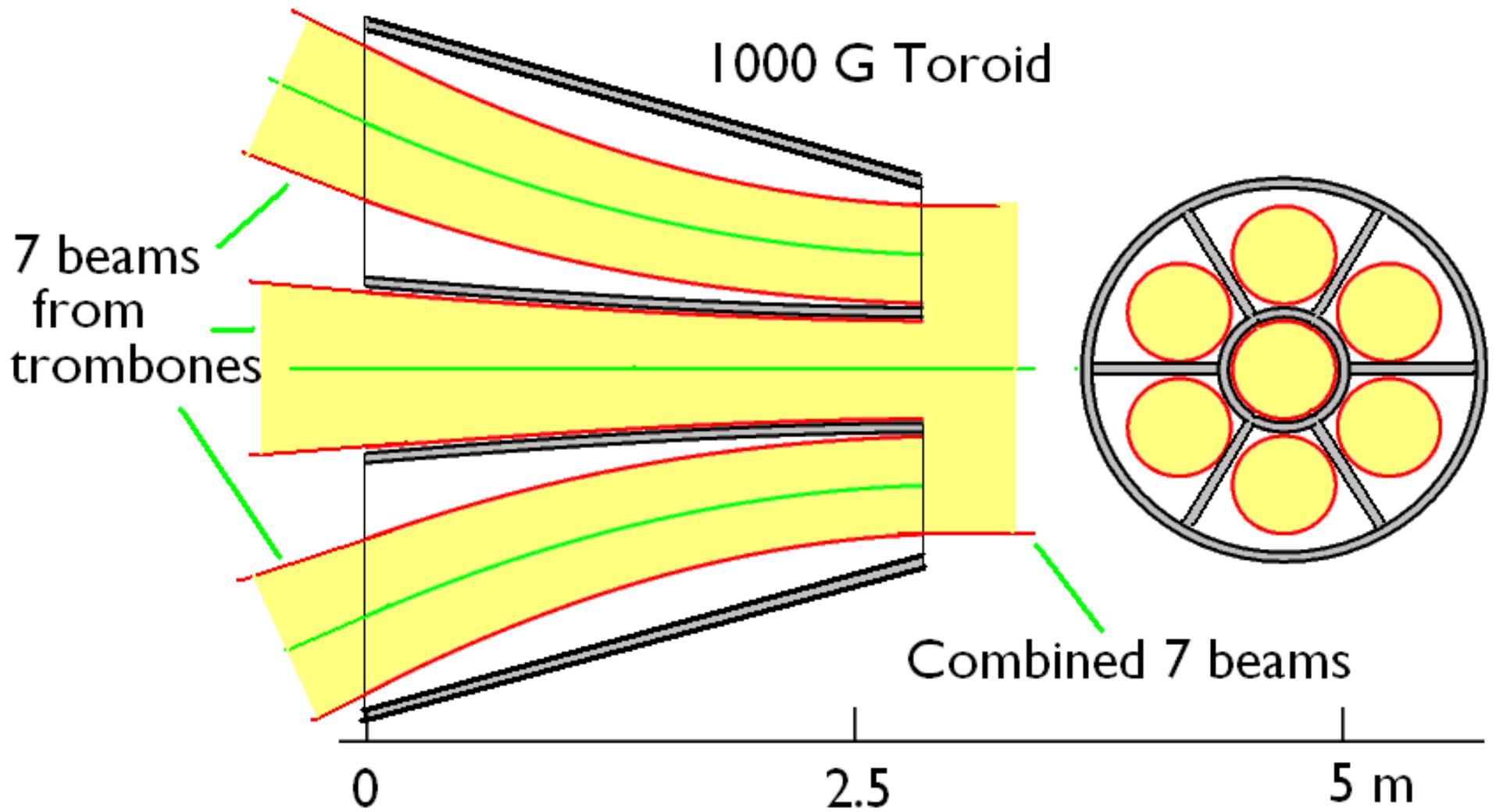
Solenoid fields	1.59	T
Curvatures	0.5678	m ⁻¹
Dipole fields	0.4	T
Arc lengths	2.766	m
rf frequencies	201	MHz
Lengths of rf in trombones	0.6	m
Initial & final rf lengths	0.3	m
Initial & final rf gradients	8.6	MV/m

Simulations of trombones done using ICOOL

	Length m	Mid \mathcal{E}_{rf} MV/m	ϵ_{\perp} mm	Dif %	ϵ_{\parallel} mm	Dif %	Transm %
Initial			1.20		8.92		100
1	8.25	0	1.20	0	8.90	-0.2	100
2	12.27	5.8	1.23	+2.5	8.85	-.7	99
3	16.20	12.2	1.25	+4.2	9.05	+1.4	98
4	20.30	17.5	1.24	+3.3	9.21	+3.3	98
ave.	14.25		1.23	2.5	9.00	0.9	98.75

Need 6(7) trombones instead of 4. Performances should be similar

Funnel merging 7 beams from 7 trombones



Old (and expected new) combined performance

	Old	New	
Initial ϵ_{\perp}	1.3	1.3	mm
Initial ϵ_{\parallel}	1.7	1.7	mm
Final ϵ_{\perp}	3.5	≈ 6.1	mm
Final ϵ_{\parallel}	9.0	≈ 9	mm
Long merge transmission	96		%
Kicker and capture	99		%
Trombone	98.75		%
Transverse funnel	98		%
Decay in $53+19=72$ m	94.5		%
Overall transmission	87		%

Conclusion

1. Longitudinal part of merge

- a new optimized 1D design for 325 MHz has been generated
- a 3D (G4BL) simulation has been started

2. Transverse part of merge

- work has started, but much remains to be done

Note:

- We are merging 6(7) bunches instead of 4 because the 325 MHz phase rotation gives more bunches
- In principal the longitudinal emittances of these bunches are less, and thus require **less** cooling before the merge
- But the merged muons after the merge have larger transverse emittances, thus requiring **more** cooling after the merge